MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | S | | | | |

INDEX NUMBER | | | | |

Paper 3 Chemistry

October/November 2012

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer any **two** questions.
Write your answers on the lined paper provided and, if necessary, continue on separate answer paper.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
Total	

Section A

Answer **all** the questions in this section.

Write your answers in the spaces provided on the question paper.

1 When completed, Table 1.1 describes laboratory tests for four gases. Fill in the blank boxes to complete the table.

Table 1.1

gas	laboratory test	result of test
ammonia	insert damp red litmus paper	turns litmus blue
oxygen		bursts into flame
chlorine	insert damp litmus paper	
sulfur dioxide	bubble into acidified potassium dichromate(VI)	

[3]

2 Iron can rust.

(a) (i) Give **two** other properties of iron.

1. .....

2. ..... [2]

(ii) Describe how iron machinery can be prevented from rusting.

.....

..... [1]

(b) A student set up an experiment to show what is needed for rust to be formed. Fig. 2.1 shows the results of the experiment after one month.

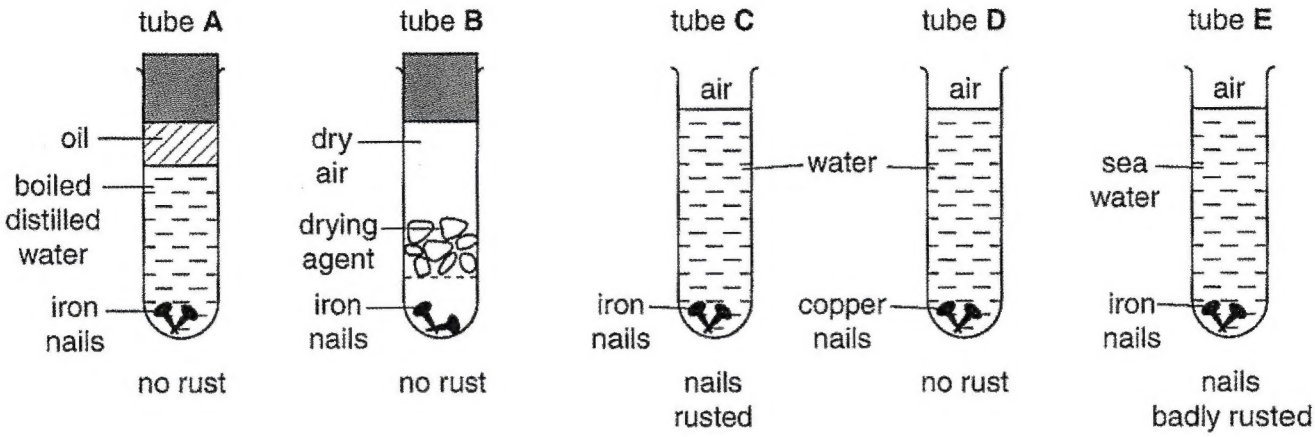


Fig. 2.1

(i) Which tube contained no water?

.....

[1]

(ii) What do the results in tube **C** and tube **D** show?

.....

.....[1]

(iii) Rust appeared in tube **C**. Which substance in air is essential for rusting to take place?

.....[1]

(iv) Iron machinery left near a sea shore rusts far more quickly than iron machinery left inland.

How do the results of this experiment support this observation?

.....

.....[1]

3 Use the Periodic Table of the Elements printed on page 16 to help in answering this question.

(a) What common name is given to the elements in

(i) Group 0, ...

(ii) Group I? .....

[2]

(b) Use your knowledge of electronic structures to answer these questions.

(i) Why do the elements in Group 0 lack chemical reactivity?

.....

.....[1]

(ii) Why are chlorine, bromine and iodine grouped together?

.....

.....

.....[1]

(iii) Explain why when moving across the Periodic Table from lithium to fluorine, the character of these elements changes from being metallic to non-metallic.

.....

.....[1]

(c) Write the formula of the compound that results from

(i) the reaction of an element from Group I with an element from Group VI,

.....

(ii) the reaction of an element from Group II with an element from Group VII.

.....

[2]

4 Fig. 4.1 describes the formation and oxidation of an organic compound, **H**.

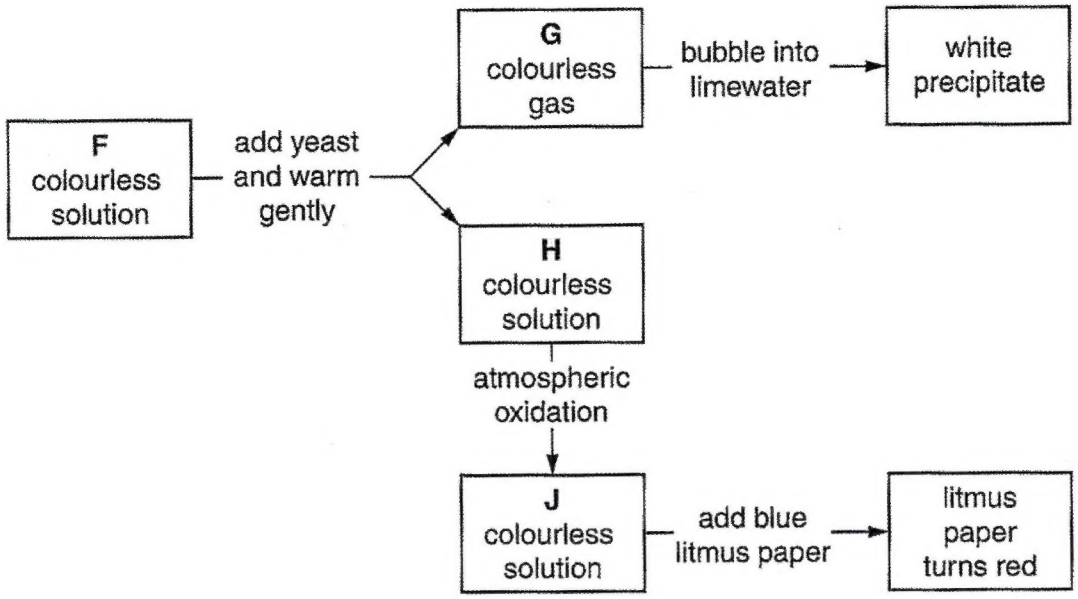


Fig. 4.1

(a) Identify **F**, **G**, **H** and **J**.

F .....

G .....

H .....

J .....

[4]

(b) Draw the structural formula of **H**.

structural formula of **H**

[1]

(c) Give the formula of the group of atoms (functional group) in a molecule of **J** that turns blue litmus red.

formula of group of atoms

[1]

5 In each of these redox equations identify the oxidising agent and the reducing agent.

(a) $2CuO + C \rightarrow 2Cu + CO_2$

oxidising agent ..... reducing agent ..... [1]

(b) $Fe + Cu^{2+} \rightarrow Cu + Fe^{2+}$

oxidising agent ..... reducing agent ..... [1]

6 **(a)** At room temperature and pressure water, H_2O, is a liquid and methane, CH_4, is a gas.

(i) Name the main type of bonding found in these compounds.

..... [1]

(ii) Use 'dot and cross' diagrams to show the electronic structure of these two molecules.

[Atomic numbers: H, 1; C, 6; O, 8]

electronic structure of water

electronic structure of methane

[4]

(b) Magnesium chloride, $MgCl_2$, has a much higher boiling point than methane.

[Atomic numbers: Mg, 12; Cl, 17]

(i) Name the type of bonding present in magnesium chloride.

..... [1]

(ii) Use your knowledge of the bonding in magnesium chloride and methane to explain the difference in boiling point.

.....

.....

.....

.....[2]

7 Identical metal carbonate tablets are reacted with solutions of the same volume and concentration of acid. The carbonate and acid are reacted at four different temperatures, **K**, **L**, **M** and **N**. The metal carbonate is in excess.

At each temperature the volume of gas produced is measured at regular time intervals. The results are shown in Fig. 7.1.

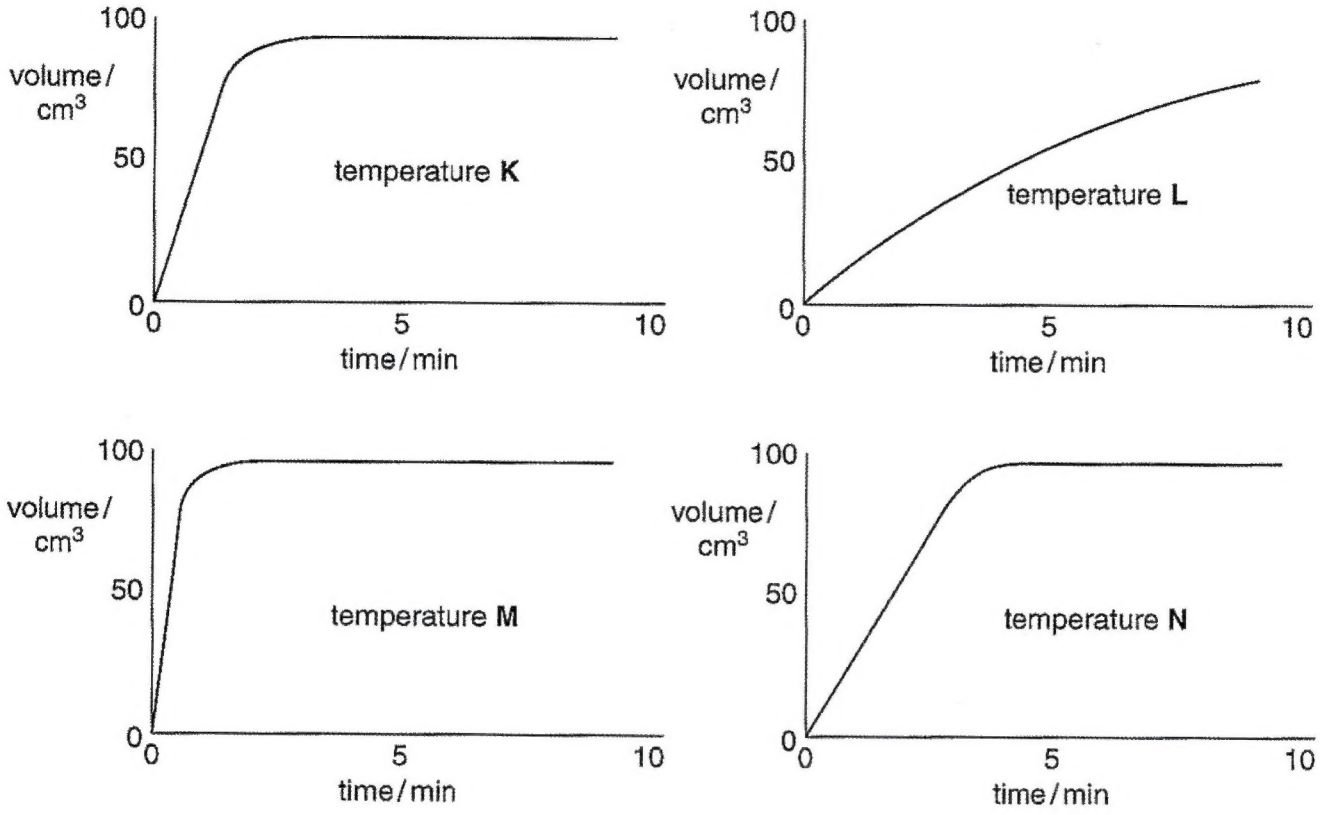


Fig. 7.1

(a) Which of the temperatures, **K**, **L**, **M** or **N**,

(i) was the lowest, ...

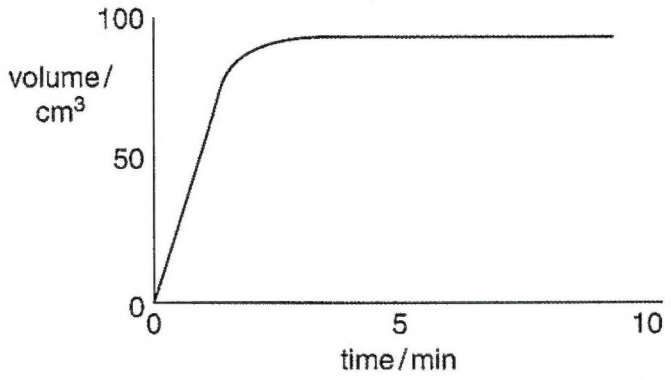
(ii) produced the fastest reaction, ...

(iii) resulted in a reaction that was still proceeding after about nine minutes? .....

[3]

(b) The experiment at temperature **K**,

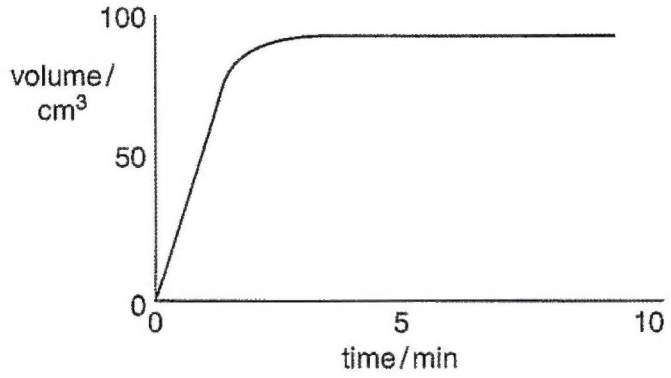
(i) is repeated using the same volume of a much less concentrated acid. Add to **Fig. 7.2** the graph you would expect. The original graph is already included.



[2]

Fig. 7.2

(ii) is repeated using the same mass of powdered metal carbonate instead of a tablet. Add to **Fig. 7.3** the graph you would expect. The original graph is already included.



[2]

Fig. 7.3

8 (a) (i) A solution is made by dissolving 53 g of sodium carbonate in water and making the volume up to 500 cm^3. Calculate the concentration, in g/dm^3, of this solution.

concentration ..... g/dm^3

(ii) A solution contains 53 g of sodium carbonate, Na_2CO_3, in 2 dm^3. Calculate the concentration, in mol/dm^3, of this solution.

[Relative atomic masses: A_r: C, 12; O, 16; Na, 23]

concentration ..... mol/dm^3
[2]

(b) (i) Write the balanced chemical equation for the reaction between sodium carbonate and hydrochloric acid. State symbols are not required.

.....[2]

(ii) How many moles of sodium carbonate will react with 4 moles of hydrochloric acid?

..... moles [1]

Section B

Answer any **two** questions.

Write your answers on the lined pages provided and, if necessary, continue on separate answer paper.

9 **(a)** Briefly describe **four** characteristic reactions of acids. [4]

(b) Describe a way to prepare a pure sample of silver chloride, AgC*l*, from silver metal. Use the following information to help you

- silver does not react with hydrochloric acid,
- silver reacts with hot concentrated nitric acid to form silver nitrate,
- all nitrates are soluble in water,
- silver chloride is insoluble in water.

[4]

(c) Write a balanced chemical equation for the reaction between a **named** metal with a **named** acid. State symbols are not required. [2]

10 **(a)** Briefly describe an experiment that shows the order of chemical reactivity of the **four** metals calcium, iron, magnesium and sodium. List the **four** metals in order of reactivity, most reactive first. [6]

(b) **(i)** Bromine, Br_2, is more chemically reactive than iodine, I_2. Bromine will react with potassium iodide, KI, to displace iodine and form potassium bromide, KBr.

Calculate the mass of iodine that is displaced when a solution containing 10g of potassium iodide reacts with excess bromine.

[Relative atomic masses: A_r: Br, 80; I, 127; K, 39]

(ii) What element could be used to displace bromine from a solution of potassium bromide? [4]

11 **(a)** **(i)** Define *nucleon number (mass number).*

(ii) Chlorine gas is a mixture of **two** chlorine isotopes. The symbols for the atoms of these **two** isotopes are, respectively, $^{35}_{17}Cl$ and $^{37}_{17}Cl$. Describe the similarities and differences in the atomic structure and electronic structure of these two atoms. [7]

(b) **(i)** Define *relative atomic mass.*

(ii) Chlorine has a relative atomic mass of 35.5. Explain why the relative atomic mass of chlorine is not a whole number. [3]

32. (D)

Sodium carbonate reacts with dilute sulfuric acid to produce carbon dioxide gas.

EXAM TIP:

Only metals above hydrogen in the reactivity series liberate hydrogen gas when reacted with dilute acid.

33. (D)

Group I metals have relatively low densities and are soft enough to be cut with a knife.

EXAM TIP:

Group I metals have relatively low densities and are soft.

34. (C)

Z lies above both hydrogen and carbon in the reactivity series since it reacts with dilute hydrochloric acid and is not reduced by carbon. X is the next most reactive as it lies above hydrogen but below carbon. Y is the least reactive as it lies below both hydrogen and carbon.

Therefore the order of reactivity is Z > X > Y.

EXAM TIP:

The most reactive metal out of the three metals is the metal that reacts with dilute hydrochloric acid and its oxide is not reduced by heating with carbon.

35. (A)

The oxidation state of oxygen decreases from 0 to –2.

$C + O_2 \rightarrow CO_2$

Carbon reduces oxygen gas to form carbon dioxide.

Carbon monoxide reduces iron(III) oxide to iron metal.

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

The oxidation state of iron decreases from +3 to 0.

EXAM TIP:

Carbon and carbon monoxide act as reducing agents in the blast furnace.

36. (A)

Carbon monoxide is produced from incomplete combustion of fossil fuels. Complete combustion produces only carbon dioxide and water.

37. (B)

P and S belong to the homologous series of alcohols as both compounds have the –OH group.

EXAM TIP:

All the members of the same homologous series share the same functional group and can be described with a general formula.

38. (C)

Methane is a small alkane that is the main component of natural gas. Diesel, naphtha and petrol are mainly made of larger alkanes, and are found as liquids at room temperature.

EXAM TIP:

Relate the physical state of methane at r.t.p. to the boiling point of each fraction of petroleum.

39. (C)

Diesel oil consists of large hydrocarbon molecules. Ethene can only be obtained from diesel through cracking of these large molecules.

EXAM TIP:

Cracking involves the breakdown of large hydrocarbon molecules into smaller ones.

40. (B)

Ethanol is oxidised by atmospheric oxygen to form carboxylic acid and water.

EXAM TIP:

An alcohol is oxidised by atmospheric oxygen to form carboxylic acid and water.

October/November 2012 Paper 3

Section A

1.

gas	laboratory test	result of test
ammonia	insert damp red litmus paper	turns litmus paper blue
oxygen	**place a glowing splint**	bursts into flame
chlorine	insert damp litmus paper	**damp litmus paper is bleached**
sulfur dioxide	bubble into acidified potassium dichromate(VI)	**solution turns from orange to green**

EXAM TIP:

Describe the result of the test in terms of colour change.

2. **(a)** **(i)** 1. Iron liberates hydrogen gas when reacted with dilute hydrochloric acid.

2. Iron can be obtained from iron(III) oxide through heating with carbon.

(ii) Iron machinery can be coated with grease.

(b) **(i)** Tube **B**

(ii) Iron is more easily oxidised than copper and is more reactive.

(iii) Oxygen

(iv) Comparing tubes **C** and **E**, the iron nails in sea water rusted more than the iron nails in water.

EXAM TIP:

Iron corrodes in the presence of water and oxygen to form rust.

3. **(a)** **(i)** Noble gases

(ii) Alkali metals

(b) **(i)** These elements have complete valence electron shells and would not react to form bonds with other atoms.

EXAM TIP:

Group 0 elements have 8 valence electrons.

(ii) These elements have 7 electrons each in their valence shells.

EXAM TIP:

Chlorine, bromine and iodine are Group VII elements.

(iii) Moving across the period, the number of electrons in the valence shell increases. With more valence electrons, it becomes harder for an atom to lose electrons but easier for it to gain electrons.

EXAM TIP:

Metals usually react by giving up electrons while non-metals usually react by accepting electrons.

(c) **(i)** Na_2O

(ii) $MgCl_2$

EXAM TIP:

Take note of the number of valence electrons of elements in each group.

4. **(a)** **F** Glucose

G Carbon dioxide

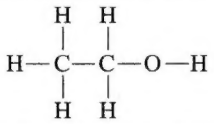
H Ethanol

J Ethanoic acid

EXAM TIP:

Identify the organic compound that undergoes fermentation.

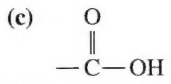
(b)



EXAM TIP:

Take note of the compound produced from fermentation.

(c)



EXAM TIP:

Acids turn blue litmus paper red.

5. **(a)** oxidising agent: CuO, reducing agent: C

(b) oxidising agent: Cu^{2+}, reducing agent: Fe

EXAM TIP:

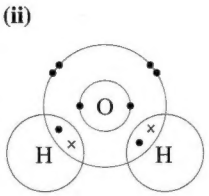
In a redox reaction, oxidising agents are reduced while reducing agents are oxidised.

6. **(a)** **(i)** Covalent bonding

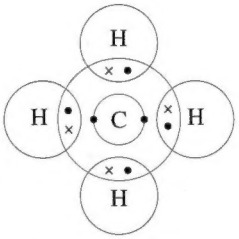
EXAM TIP:

Covalent bonds are formed between non-metal atoms and are formed by sharing of electrons between atoms.

(ii)



electronic structure of water



electronic structure of methane

(b) **(i)** Ionic bonding

(ii) In magnesium chloride, the ions are held together in a lattice by strong electrostatic forces of attraction.

In methane, the molecules are held together by weaker intermolecular forces of attraction, thus smaller amount of energy is required to overcome them.

Therefore, magnesium chloride has a much higher boiling point than methane.

EXAM TIP:

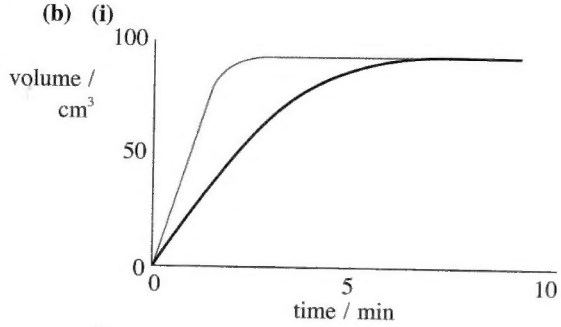
Covalent compounds have low boiling points while ionic compounds have high boiling points.

7. **(a)** **(i)** **L**

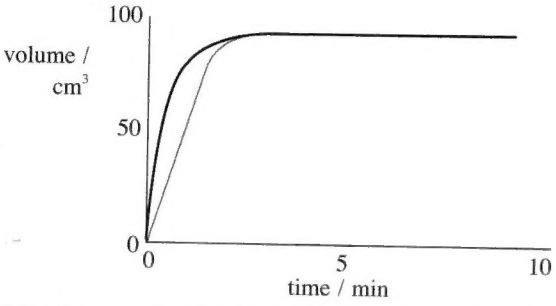
(ii) **M**

(iii) **L**

(b) (i)



(ii)



EXAM TIP:

The steeper the curve, the faster the reaction.

8. (a) (i) Concentration $= 53 \div \frac{500}{1000}$

$= \underline{106 \text{ g / dm}^3}$

EXAM TIP:

$\text{Concentration (g / dm}^3) = \frac{\text{Mass of compound (g)}}{\text{Volume of solution (dm}^3)}$

(ii) Number of moles of sodium carbonate

$= \frac{53}{106}$

$= 0.5 \text{ mol}$

$\text{Concentration} = \frac{0.5}{2}$

$= \underline{0.25 \text{ mol / dm}^3}$

EXAM TIP:

$\text{Concentration (mol / dm}^3) = \frac{\text{Concentration of solution in g / dm}^3}{\text{Molar mass of reactant in g / mol}}$

(b) (i) $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

EXAM TIP:

Carbonates react with acids to form a salt, carbon dioxide and water.

(ii) Number of moles of sodium carbonate

$= \frac{4}{2} \times 1$

$= \underline{2 \text{ mol}}$

Section B

9. (a) Acids react with metal carbonates to produce a salt, carbon dioxide and water.

Acids undergo neutralisation with alkalis to produce a salt and water.

Acids react with reactive metals to produce a salt and hydrogen gas.

Acids react with ammonia to form ammonium salts.

EXAM TIP:

Acids can react with reactive metals, alkalis, metal oxides and metal carbonates.

(b) Add excess silver to hot concentrated nitric acid and stir until there is no further reaction. Filter the mixture to separate the excess silver metal from the silver nitrate solution. Add sodium chloride solution to the silver nitrate solution. A white precipitate of silver chloride will be formed. Filter the mixture to obtain silver chloride. Wash the salt with distilled water and dry with filter paper.

(c) Magnesium metal reacts with dilute hydrochloric acid to form magnesium chloride and hydrogen gas.

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

EXAM TIP:

Only reactive metals can react with acids.

10. (a) The reactivities of the metals can be determined by observing how they react with cold water or steam. Take a piece of each metal and place them in separate test-tubes of cold water.

Sodium reacts the most vigorously and may catch fire as a lot of heat is generated. Calcium reacts readily and many bubbles of hydrogen gas will be produced. Magnesium reacts very slowly and a small amount of gas bubbles will be observed on the surface of the metal. Iron is the least reactive and does not react.

The order of reactivity of the metals is sodium > calcium > magnesium > iron.

EXAM TIP:

The more reactive a metal, the more vigorously it reacts with cold water or steam.

(b) **(i)** Number of moles of KI $= \frac{10}{166}$

$= 0.0602$ mol

$2KI + Br_2 \rightarrow 2KBr + I_2$

Number of moles of iodine produced

$= \frac{0.0602}{2} \times 1$

$= 0.0301$ mol

Mass of iodine produced $= 0.0301 \times 254$

$= \underline{7.65\ g}$

EXAM TIP:

Mass = Number of moles × Molar mass

(ii) Chlorine

EXAM TIP:

The element must be more reactive than bromine in order to displace bromine from a solution of potassium bromide.

11. **(a)** **(i)** The nucleon number gives the sum of the number of protons and neutrons present in the nucleus of an atom.

(ii) <u>Similarities</u>

The atoms of ^{35}Cl and ^{37}Cl have 17 protons each. Atoms of both isotopes have 17 electrons as well. They form ions of charge 1–.

<u>Differences</u>

Atoms of ^{35}Cl have a nucleon number of 35 while atoms of ^{37}Cl have a nucleon number of 37. Since atoms of both isotopes have the same proton number but different nucleon numbers, atoms of ^{35}Cl have 18 neutrons while atoms of ^{37}Cl have 20 neutrons.

EXAM TIP:

Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons.

(b) **(i)** Relative atomic mass is the average mass of an atom compared to the mass of $\frac{1}{12}$ of an atom of carbon-12.

(ii) Chlorine has two naturally-occurring isotopes, ^{35}Cl and ^{37}Cl with natural abundances of about 76% and 24% respectively. An average is taken based on the relative abundance and this does not give a whole number.